close to the subduction zone. In the depth shallower than 400 km, the increase of seismic activity is to be expected at temperature of 500 600 °C with differential stress less than 1 GPa. In the depth deeper than 400 km, the properties of the olivine high- pressure polymorphs (wadsleyite and ringwoodite) control the seismicity. Higher temperatures (650 °C) are required of these phases to access the plastic instability process, thus allowing seismicity to increase in this region. This model may well represent the plastic instability for intermediate and deep earthquakes.

S62C-1210 1330h POSTER

Multitaper Multiple-ScS Analysis Beneath the Southwestern Pacific

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The pair of deep Tonga-Fiji earthquakes on August 19, 2002 provide a unique opportunity to measure mantle-attenuation properties beneath the Equatorial Pacific. Deep earthquakes in this region are common, but the large size and focal mechanisms of both events create favorable conditions for the generation of ScS phases. Multiple-ScS phases recorded in French Polynesia and BATS (Broadband Array in Taiwan for Seismology) stations are used with additional data from IRIS stations (when it becomes available). Because the earthquakes occurred approximately eight minutes apart, ScS phases for each event are evenly spaced in teleseismic records and we use phases from both events when possible. An estimate of an attenuation quality factor (Q_{ScS}) was determined by a modified spectral-ratio method for successive ScS phases. Our modification to this classical technique is in estimating the spectra with the multitaper method to control spectral variance without arbitrarily smoothing the estimate.

We use multiple-ScS phases from the August 19th events to measure Q_{ScS} for mantle structures west of the source region along the Solomon Islands and to the east beneath the South Pacific Superswell. Similar to previous studies, we measure low Q_{ScS} between the Tonga-Fiji events and stations in French Polynesia. We identify a range of Q_{ScS} values from 60 to approximately 160 throughout the South Pacific Superswell. These results support the existence of high-temperature anomalies in the upper mantle. Measurements for stations in the BATS network produce less consistent and,generally, higher Q_{ScS} values that range from 120 to above 400. This result is expected since they sample a more diverse geologic setting including subducting slabs and oceanic plateaus.

S62C-1211 1330h POSTER

Preliminary results of field survey, 2002 PNG earthquake at Wewak

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We report on field observations taken in the immediate aftermath of the PNG earthquake of 08 Sept. 2002 (09 Sept. local time). This event occurred about 100 km ESE along the coast from the location of the 1998 tsunami disaster. The 2002 event had a significantly larger magnitude (7.4), but triggered a much more benign tsunami. Fortunately, it resulted in only a handful of casualties.

The following is a summary of preliminary observations during field surveys taken in the week following the event: The islands facing the coast (Mussu, Kairiru, Walis) were uplifted from 20 to 50 cm, and suffered a number of local aerial landslides. By constrast, along the main New Guinea coast, sea level change was barely detectable, but that part of the coast suffered many instances of liquefaction. The runup of the tsunami is estimated at 1.5 to 2 meters along the coast and on the islands.

A more complete report, inclusive of observations posterior to the abstract, will be presented.

S62C-1212 1330h POSTER

Seismological Aspects of the 2002 Papua New Guinea and Andaman Earthquakes and Tsunamis

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On September 8 and 13, 2002, two earthquakes resulted in minor tsunamis with preliminary reports of a few casualties in Papua New Guinea (PNG) and the Andaman Islands, respectively. Of particular interest is the PNG event which occurred just 100 km from the catastrophic 1998 tsunami. By contrast the 2002 source has a much larger moment, but generated only a moderate tsunami. We present the results of quasi-real time processing of its source characteristics (M_m = 7.4 and $\Theta = Log_{10}\ E^E\ /\ M_0 = -4.82$) which characterizes the earthquake as having a regular source slowness. The minor 2002 tsunami gives additional support to the interpretation of the 1998 tsunami as generated by a triggered underwater landslide. We will present results of an ongoing survey of felt intensities.

Preliminary results on the Andaman Island event of September 13th also confirms a regular source slowness ($\Theta = -4.73$).

We will present updated results on the interpretation of the reportedly minor tsunami.

S62C-1213 1330h POSTER

Preliminary Modeling of Tsunami Waves Generated by the Earthquake of 9 September 2002 Offshore of Northern Papua New Guinea

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On September 9, 2002 at 0444 local time (September 8, 2002 1844 UTC) an earthquake struck the northern coast of Papua New guinea near 3.3 degrees south and 143.1 degrees east. Preliminary estimates centered the earthquake offshore some 100 km northwest of the town of Wewak with a moment magnitude of 7.5. Initial news reports stated that the earthquake generated a moderate tsunami which killed 4 people and damaged waterfront structures along the north coast and on offshore islands. Preliminary tsunami simulations based on a simple fault model suggest runup values of up to 1.5 m along the open coast Papua New Guinea west of Wewak. A preliminary field survey immediately after the event confirmed the tsunami and reported runup heights of generally less than 1 m with some locations receiving up to 1.5 m of runup and one unconfirmed report of over 3 m runup. Tsunami waves were reported over 200 km of coast from Aitape in the west to the mouth of the Sepik River in the east, consistent with preliminary models based on a seismic source.

URL: http://www.usc.edu/dept/tsunamis/

S62D MCC: 106 Saturday 1330h

Lithospheric Structure in North America and Europe: Comparisons and Recent Results II *(joint with T, V)*

Presiding: **A Guterch,** Polish Academy of Sciences**; G R Keller,** University of Texas at El Paso

S62D-01 1330h

Deep Crustal Structure underneath British Isles and Links with Surface Uplift and Denudation

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We present a new crustal and upper mantle model constructed by modelling wide-angle data from the Caledonian Suture Seismic Project and its Irish extension, both acquired in 1982. The line is oriented NE-SW and crosses the British Isles from offshore Northumberland to the Shannon Estuary. We are specially interested in the fact that this line crosses a zone of major Cenozoic denudation. Combined 2D velocity models were developed by forward and inverse modelling of 3000 travel-time picks of the principal seismic phases. The most striking feature of these models is the existence of a high velocity (7.27.7 kms-1) layer at the base of the crust, which exhibits a very low velocity gradient. The top interface of this layer is extensively sampled by lower crustal reflections, whereas the base of this layer (which corresponds to the Moho interface at 33 km) is bounded by upper mantle diving rays. The velocity of the layer is constrained by refracted energy through the layer. Moho reflections are also observed, but the majority is believed to be masked by an early arriving, high amplitude seismic coda generated by resonance of the seismic energy within the layer. The high velocity layer has a maximum thickness of 82 km beneath the Irish Sea and it wedges out towards the northeast and southwest, giving a minimum width of 600 km. Amplitude modelling was carried out using 1D full waveform and 2D ray-tracing codes and corroborates the travel-time modelling. The crustal structure along the combined profile was confirmed by gravity modelling. The high velocities and densities of the lower crust are probably underplated igneous rocks, which can be associated with the break-up of the North Atlantic Ocean. This result is tested by comparing the magnitude and wavelength of modeled denudation with those predicted by the presence of underplating in the lower crust. Predicted and observed denudation profiles are in a good agreement. This agreement together with the regional long-wavelength gravity field is used to predict the three-dimensional distribution of underplating across the British Isles. The results of this study are, finally, integrated with other regional studies in an attempt to understand the spatial and temporal evolution of the Ireland plume. These findings support the hypothesis that the Iceland plume has formed at the conjunction of a tetrad hot, subvertical, convective sheets. The impingement of these hot sheets at the base of the lithosphere has trigged the episodic injection of substantial quantities of melt.

S62D-02 1345h

Structure and Dynamics of the Dead Sea Transform in the Middle East

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Despite numerous efforts to study large transform systems, especially at the San Andreas Fault (SAF) system, the processes responsible for large continental-scale shear zones, one of the key elements of plate tectonics, and their relation and interaction with the crust and upper mantle are still not fully understood. The Dead Sea Transform (DST), at the border between Israel and Jordan, has for a long time been considered a prime site to examine large shear zones, but due to the political situation in this area no geoscientific profile has crossed the DST. Moreover, studies of historical earthquakes of the past few thousand years, paleoseismic studies and instrumental earthquake studies demonstrate that a number of damaging earthquakes have occurred along the DST. The DST therefore poses a considerable seismic hazard to Israel, Jordan, and the Palestine Authority.

A geophysical profile crossing the DST, the boundary between the African and Arabian plates in the Middle East, and the border between Israel and Jordan, has been completed for the first time. High-resolution seismic tomography and magnetotelluric sounding of the shallow crust show drastic lateral changes in material properties within a narrow zone around the DST. The seismic basement is offset by 3-5 km under the DST, and strong lower-crustal reflectors are imaged east of the DST. The seismic velocity sections show a steady increase in the depth of the crust-mantle transition (Moho) from 26 km at the Mediterranean to 38-39 km under the Jordan highlands, but only small topography of the Moho under the DST. These observations can be linked to the left-lateral movement of the two plates of 105 km in the last 17 Ma accompanied by strong deformation within a 20-30 km wide zone cutting through the entire crust. Sub-horizontal lower-crustal reflectors and deep reaching deformation zones occur in the DST (originating in a relatively homogeneous cold and stable lithosphere; slow relative plate motion of ca 0.5 cm) and also in the San Andreas Fault system (originating in a strongly heterogeneous, hot lithosphere; fast relative plate motion of ca. 3.5 cm). The fact that lower-crustal reflectors and deep deformation zones are observed in transform systems of such different origin could suggest that these structures are fundamental features of large transform plate boundaries.

S62D-03 1400h

Thermo-mechanical Model of the Dead Sea Transform

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The Dead Sea transform system (DST) is the boundary between the Arabian and African plates, where left-lateral transform motion has largely accommodated the opening of the Red Sea basin during the last 15-20 My. One of the key questions related to this plate boundary is whether the DST crosses the crust and mantle lithosphere, and how the rheologically different units composing the lithosphere interact during strong deformation? Another major question is how important is the rifting (transform-perpendicular extension) deformation component at the DST? We address these questions using the internally consistent finite element thermo-mechanical modelling of the lithospheric deformation constrained by high-resolution geophysical observations and especially by the recent geophysical data of the DESERT Project.

From our modelling, we conclude that the DST lithospheric structure is controlled by the plate-scale transform displacement within a relatively cold and strong lithosphere. In such a lithosphere, shear strain is localized in a narrow (20-40 km wide) vertical decoupling zone (VDZ), which crosses the entire lithosphere and even continues into the asthenosphere. In the upper crust the deformation localizes at one or two major faults located at the top of this zone. The location of the VDZ is controlled by the temperature of the uppermost mantle prior to the transform motion. Most of the lithospheric structures imaged along the DESERT seismic line is explained by the 105 km transform motion combined with less than 4 km transform-perpendicular extension.

Uplift of the Arabian Shield adjacent to the DST can be explained by young (<20 Ma) thinning of the lithosphere at and east of the plate boundary. Such lithospheric thinning is consistent with seismological observations, with the low present-day surface heat flow and with the high temperatures derived from mantle xenoliths brought up by Neogene-Quaternary basalts. Taking into account the timing of the onset of the volcanism, we suggest that the lithospheric thinning in the southern part of the DST, likely related to the opening of the Red Sea, may have enabled transform motion at the DST by lowering the strength of the Arabian Shield lithosphere.

S62D-04 1415h

Electrical Conductivity Model of the Mantle Lithosphere of the Slave Craton (NW Canada) and its tectonic interpretation in the context of Geochemical Results

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The Slave Craton, northwestern Canada, contains the oldest known rocks on Earth, with exposed outcrop over an area of about 600x400 km^2. The discovery of economic diamondiferous kimberlite pipes during the early 1990s motivated extensive research in the region. Over the last six years, four types of deep-probing magnetotelluric (MT) surveys were conducted within the framework of diverse geoscientific programs, aimed at determining the regional-scale electrical structures of the craton. Two of the surveys involved novel acquisition; one through frozen lake ice along ice roads during winter, and the second deploying ocean-bottom instrumentation from float planes during summer. The latter surveys required one year of recording between summers, thus allowing long period transfer functions that lead to mantle penetration depths of over 300 km.

Two-dimensional modeling of the MT data from along the winter road showed the existence of a high conductivity zone at depths of 80-120 km beneath the central Slave craton. This anomalous region is spatially coincident with an ultradepleted harzburgitic layer in the upper mantle that was interpreted by others to be related to a subducted slab emplaced during the mid-Archean. A 3-D electrical conductivity model of the Slave lithosphere has been obtained, by trial and error, to fit the magnetic transfer and MT response functions from the lake experiments. This 3-D model traces the central Slave conductor as a NE-SW oriented mantle structure. Its NE-SW orientation coincides with that of a late fold belt system, with the first phase of craton-wide plutonism at ca 2630-2590 Ma, three-part subdivision of the craton based on SKS results, and with a G10 (garnet) geochemical mantle boundaries. All of these highlight a NE-SW structural grain to the lithospheric mantle of the craton, in sharp contrast to the N-S grain of the crust. Constraints on the depth range and lateral extension of the electrical conductive structure are obtained through a sensitivity analysis to verify a recent hypothesis about tectonic imbrication of lithosphere emplaced at ca 2.6 Ga in which SE-NW subduction is proposed. If such subduction has taken place, and arc-related or oceanic lithosphere has been trapped in the system, then an enhanced conductivity in the mantle deepening to NW supports the tectonic model.

S62D-05 1430h

Great Contrasts in Lithospheric Structure Across and Along of the Trans-European Suture Zone in Central Europe

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A large seismic experiment (CELEBRATION 2000) targeted the deep structure in the Central Europe between the Phanerozoic an Proterozoic European crustal domains. A feature of this experiment was seismic measurements along a 1400 km long profile (CEL05) located perpendicular to the Trans-European Suture Zone (TESZ). Modeling of data along this profile has determined details of crustal structure of the East European Craton (EEC), TESZ (including the Holy Cross Mountains), Carpathians and Pannonian basin. The crustal thickness beneath profile CEL05 changes from about 43-47 km beneath the EEC to about 30-40 km beneath the Paleozoic Platform and Carpathians, and to only 24-28 km beneath the Pannonian basin. Depths of the consolidated basement with velocity Vp>6.0 km/s changes from 1-3 km beneath the East European Craton to about 5-8 km beneath the Pannonian basin, reaching up to 10-18 km in the TESZ and Carpathians. The velocity in the uppermost mantle is 8.1-8.25 km/s beneath East European Craton and 7.8-8.0 km/s beneath the Carpathian-Pannonian area. Other profiles (TTZ and CEL03) with a total length of 720 km are located parallel to the axis of the TESZ in Poland. In this area, the depth of the consolidated basement, with a P-wave velocity of about 5.8 km/s, is from 8 to 10 km. However, down to a depth of 15-20 km, the P-wave velocity is very low, not greater than about 6.0 km/s. The depth of Moho boundary strongly changes along these profiles from 37 km to the NW, through 50 km in central Poland, and jumps to 43 km to the SE. Sub-Moho velocities vary from 8.2 km/s in the NW part, through 8.35-8.45 km/s in]central Poland, to 8.15 km/s to the SE. An approximately 15 km thick lower lithosphere layer with a velocity of 8.2 km/s was detected below the uppermost mantle.
*The CELEBRATION Working Group is listed on our website

URL: http://paces.geo.utep.edu/celebration.shtml

S62D-06 1445h

New Results Provided by the CELEBRATION 2000 Experiment in the Pannonian Basin

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In the second half of the 20th century, a significant amount of geophysical data was collected in Hungary. To utilize these data the Etvs Lornd Geophysical Institute started a new project whose goal is to integrate all geophysical data in an interpretation process that builds a new 3D geological model of the crust below Hungary. The CELEBRATION 2000 lithospheric experiment provided a large amount of new data, which we have interpreted with 3-D tomographic techniques, that contributed to this integrated interpretation with major implications as far as the deep structure of the Pannonian basin is concerned: (1) In northeast Hungary, all known geological and tectonic maps show WSW-ENE trends more or less perpendicular to the Carpathian arc, the dominant tectonic feature. Here the axes of the prominent velocity anomalies provided by CELEBRATION data have NNW-SSE trends, apparently in contradiction with the WSW-ENE direction typical for the Pannonian pre-Neogene basement. The main direction of the anomalies corresponds much more to the direction of the Carpathian arc than that of the known geology of the Pannonian basin. (2) In the western part of the Pannonian basin, a comparison of tomographic seismic velocity profiles for the CEL07 and CEL08 lines with deep seismic reflection sections and magnetotelluric soundings reveals a number of phenomena which may significantly influence the present concept of the deep structure and the evolution of the Pannonian Basin and its surroundings. These data suggest that the so-called "Rba-line" is, instead of being a low-angle oblique-slip fault, really a deep shear zone cutting through the crust and can be considered as a micro-continental boundary. (3) In northern Hungary, the Mtra Mountains are of volcanic origin. Significant amounts of Paleogene/Neogene sediments are buried beneath this mountain range. In addition, a mid-Miocene caldera coincides with a velocity anomaly appearing as pillar under it. This anomaly is probably due to the batholithic source for the volcanic material. *The CELEBRATION 2000 WORKING GROUP is listed on our website.

URL: http://paces.geo.utep.edu/celebration.shtml

S62D-07 1520h

3-D Crustal Velocity Structure Across the Vrancea Zone in Romania, Derived From Seismic Data

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The Vrancea zone in the south-eastern Carpathians is one of the most active seismic zones in Europe. In order to study the crustal and upper-mantle structure in this region, two seismic refraction/wide-angle reflection experiments were carried out in 1999 and 2001. The 1999 campaign comprised a 320 km long N-S profile and a 80 km long transverse profile (E-W). All shots were recorded simultaneously on both profiles. The profile conducted in 2001 extended in E-W direction from the Hungarian border across the Vrancea zone to the Black Sea.

We present an application of a 3-D refraction and reflection tomography algorithm (Hole 1992, 1995), elaborating the crustal velocity and interface structure within a 115 x 235 km wide region around the Vrancea zone. In order to enhance the model resolution, first arrival data from local earthquakes of the CALIXTO-99 teleseismic project were also included.

The results indicate a high-velocity structure beneath the northern part of the Vrancea zone extending from shallow levels to depths of about 11 km. This structure may be related to the Trotus and Capidava-Ovidiu faults, which converge to the north of it. The high-velocity region is surrounded by the lower velocity Focsani and Brasov basins. The sedimentary succession beneath the southern part of the model extends to 18 km depth, while in the north sediment thickness varies between 10 and 15 km. Further results of the interface modelling of prominent reflections show that the mid-crustal and Moho interfaces shallow northwards from 30 km to 22 km and from 42 km to 38 km, respectively. This correlates well with previous results of Hauser et al. (2001).

URL: http://www-sfb461.physik.uni-karlsruhe.de

S62D-08 1535h

DOBREfraction99 Velocity models of the crust and upper mantle beneath the Donbas Foldbelt (SE Ukraine)

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The Pripyat-Dniepr-Donets basin (PDD) is a Late Devonian rift basin located on the southwestern part of the East-European Craton (EEC). This rift basin strikes in a southeasterly direction and extends from Belarus through Ukraine, where it connects with the Donbas foldbelt and its continuation as the deformed southern margin of the craton (Karpinsky Swell) in southern Russia. The Pripyat and Dniepr-Donets basins are important hydrocarbon provinces. The Donbas foldbelt (DF) is the uplifted and deformed part of the 20-km thick Dniepr-Donets basin. In 1999, an international cooperative deep seismic sounding (DSS) experiment (DOBREfraction99) was undertaken. This effort involved 11 in-line shotpoints and deployment of some 245 recording stations along a northeast-trending, 360 km long profile extending from the shores of the Azov Sea in the south, across the Azov Massif (Ukrainian Shield), the DF, ending at the Ukraine-Russia border in the Voronezh Massif of the EEC. Particular scientific targets included the nature of the crust-mantle transition and the geometry of crustal/upper mantle structures related to rifting and subsequent basin inversion. Tomographic inversion, as well as, ray-trace based velocity modelling has been carried out. The velocity signature of the sedimentary basin itself is well resolved, indicating an asymmetric form (basement surface dipping more gently towards the center of the basin from the north than from the south) and a total thickness of about 20-km, comparable to estimates derived from previous seismic studies and geological interpretations. A thick (>10-km), high-velocity (>6.9 km/s), lower crustal body lies beneath the rift basin itself. This layer forms a domal structure that is offset slightly to the north compared to the main basin depocenter. A thinner (5-km) high velocity layer is inferred beneath the southern margin of the Donbas foldbelt and Azov Massif. The former could be related to Permian uplift with the latter being due to the earlier rifting processes. Velocities in the crust below the Azov Massif, south of the DF, are in general higher than beneath the Voronezh Massif to the north. The Moho displays some topography but lies at a depth of about 40-km along the profile.

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S62D-09 1550h

Crustal and Lower Lithospheric Structure of the TESZ Between Precambrian and Paleozoic Platforms in the Central Europe from POLONAISE'97 Seismic Profiles

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In Europe, the structure and evolution of the contact between Precambrian terranes to the northeast and younger, Phanerozoic terranes to the southwest is still one of the most interesting geological and tectonic problems. The Trans-European Suture Zone (TESZ) represents the most prominent lithospheric boundary in Europe north of the Alpine-Carpathian orogenic front. Over most of its length, the TESZ is concealed beneath younger basins filled with Permo-Mesozoic and Cenozoic sedimentary sequences. From a plate tectonics perspective, the TESZ, in a general sense, can be correlated across the Atlantic Ocean to the Appalachian orogen, where its equivalent is probably represented by the boundary between the Avalon terrane to the SE and the North American craton to the NW. In the TESZ region, the results of the large-scale POLONAISE97 seismic experiment delineated the presence of relatively low velocity rocks (Vp<6.1 km/s) of sedimentary, metamorphic or volcanic origin down to a depth of 20 km and high velocity (Vp=6.87.3 km/s) lower crust. The thickness of the crust is 30 km beneath the Paleozoic platform, 40-45 km beneath the TESZ, and 40-50 beneath the East European craton (EEC). This transition in crustal structure takes place across a 200 km wide zone centered on the Polish trough. The P-wave velocity of the sub-Moho mantle is >8.25 km/s in the Paleozoic platform and 8.1 km/s in the EEC. A seismic reflector in the depth range of 50-90 km appears as a general feature at around 10 km depth below Moho in the area, independent of the Moho depth and sub-Moho velocity. "Ringing reflections" in the lower lithosphere are explained by relatively small-scale heterogeneities in the depth interval 90-110 km. The 90 km deep reflector may mark a change in upper mantle structure from a zone of small vertical dimension scatterers to a deeper zone with vertically larger seismic scatterers, possibly caused by inclusions of partial melt.

* The POLONAISE Working Group is listed on our website.

URL: http://paces.geo.utep.edu/geology.shtml

S62D-10 1605h

Lithospheric Signature of Paleorifts in Cratonal Europe and North America

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Southwestern North America and Central Europe share many aspects of their Neoproterozoic and Phanerozoic tectonic evolution. In particular, the break-up of late Precambrian supercontinent created the continental blocks called Laurentia and Baltica. Passive margins developed during and after the rifting that formed these continents, and these margins were deformed by Paleozoic orogenies (Appalachian-Ouachita; Caledonian-Variscan respectively). Our group has studied the Ouachita orogeny that affected southern Laurentia for many years and has recently had the opportunity to study Central Europe by participating in several large seismic experiments. The results of the POLONAISE 97 experiment delineated the rifted margin of Baltica, and we interpret it to be quite similar to crustal models we have developed for the Ouachita margin. For example, the Holy Cross Mountains in southern Poland exposed a crustal block that is similar to the Devils River uplift in west Texas. The Polish basin contains a thick pre-Permian section similar to that observed along the Ouachita orogenic belt that is overlain by a Permian and younger sequence that is analogous to the Gulf Coast sequence. Both the Variscan orogeny in Central Europe and the Ouachita orogeny appear to be the result of soft collisions that have left the pre-orogenic rifted margins largely intact. In terms of continental tectonics, rifts that do not succeed in breaking a continent apart are sometimes referred to as having failed. These failed rifts usually are the sites of post-rift sedimentation that contain important records of continental evolution and prolific petroleum resources. During the past 15 years, a number of studies have shown that the modification of the lithosphere (most evidence is actually for the crust) in failed rifts takes on many forms, is highly variable, and is often very substantial. Although semantic arguments are seldom productive, these results call into question any perception that these intracratonic rifts are not major lithospheric scale structures. We have revisited a classic analogy that was drawn between two major intracratonic rifts, the Southern Oklahoma aulacogen in the southern portion of Laurentia and the Dniepr-Donets basin in the southern portion of Baltica, and these features display both similarities and differences. In particular, magmatic modification of the upper crust dominates in the Southern Oklahoma aulacogen, while modification of the lower crust dominates in the Dniepr-Donets aulacogen. In both cases, the syn- and post-rift sedimentary fill is at least 15 km thick.

S62D-11 1620h

Crustal Growth in the Rocky Mountains Based on Seismic Refraction/Wide-Angle Reflection Data

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The results from the Deep Probe '95 and CD-ROM '99 refraction wide/angle reflection experiments have lead to varying discussions on the crustal evolution of the Rocky Mountain region. One of the major results from the Deep Probe project is evidence for a high-velocity lowermost crustal (HVLC) layer (7.0 - 7.3 km/s) beneath the Wyoming province. The crust thickens dramatically beneath the province to 50+ km. The HVLC layer is about 20 km thick at the base of the crust and extends >100 km in the north-south direction. In contrast, the CD-ROM velocity model exhibits evidence of a mid-crustal discontinuity at about 20 to 25 km, which corresponds to the "Conrad" discontinuity. The "Conrad" discontinuity is typically associated with a stable cratonic environment and is not commonly seen. The presence of this discontinuity in the CD-ROM velocity model may indicate that portions of the Rocky Mountains were built on stable cratonic crust. In addition, the southern end of the profile, which crosses the Great Plains, shows evidence of a high-velocity lowermost crustal layer (7.0 to 7.4 km/s). This CD-ROM HVLC ranges in thickness from 5-10 km and is most evident under the Great Plains. In contrast to the Deep Probe model, the CD-ROM layer is interpreted to have been created and modified during the Proterozoic and is spatially associated with the widespread magmatism (1.3 - 1.4 Ga) that has been identified in the mid-continent and the Colorado Plateau. Although the process for creating such HVLC layers is probably very similar, the age, extent, geologic cause, and crustal structure of these layers from Deep Probe and CD-ROM are distinctly different. Recent studies have shown that HVLC layers are typically associated with magmatic underplating as seen in the Kenya rift or with tectonic underplates associated with subduction zones such as recently proposed for the southern Baltic shield, the Pacific Northwest, and the Aleutians. These observation from the Deep Probe and CD-ROM experiments pose several questions: 1) What process created the HVLC layer beneath the Wyoming province and the HVLC under the Great Plains? 2) What is the age of these HVLC layers? 3) How common are these layers in other locations around the world? 4) What does the presence of a "Conrad" discontinuity in the Rocky Mountains suggest for crustal evolution? The crustal evolution of North America is in part represented in the velocity models produced from the Deep Probe and CDROM experiments. The integration of

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these results with recent geologic and geophysical studies will attempt to answer some of these unanswered questions.

S62D-12 1635h

Deep Seismic Reflection Signature of Mafic Magmatic Underplates at the Base of Continental Crust

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Seismic reflection images of Precambrian crust in the United States are characterized by diffuse reflectivity in the lower crust and a lack of distinct reflections that mark the crust-mantle transition. By contrast, the base of the crust in extended terranes is commonly marked by pronounced sub-horizontal reflectivity in the lower crust that abruptly terminates at the Moho. Whereas this subhorizontal reflectivity is now known to be characteristic of extended regions globally, the diffuse reflectivity seen at the base of Precambrian crust is not. In fact, seismic reflection images from Canada, Scandinavia, and other Precambrian terranes usually exhibit very strong reflectivity to Moho.

Here I demonstrate that where seismic reflection records have diffuse reflectivity in the lower crust and little reflectivity to mark the Moho, seismic refraction data show that the base of the crust is comprised of a layer of mafic material with velocities greater than 7 km/s. Places where this correlation occurs include Montana, the Colorado Plateau, the southern mid-continent of the United States, north central New Mexico, and the Abitibi Belt of eastern Canada. All of these regions are associated with a period of extended Precambrian magmatism that occurred subsequent to initial assembly of the continent. I propose that the diffuse reflectivity is characteristic of regions where mafic magmas have ponded at the base of the crust, but have not penetrate it in significant volumes. Few reflections occur because impedance contrasts within the mafic layer are small. Extended terranes are also sometimes associated with a layer with velocities greater than 7 km/s. However, the observation of subhorizontal reflectivity in the lower crust of these regions suggests that the mafic magmas have penetrated the crust so that strong impedance boundaries are developed between mafic sills and surrounding felsic crust.

S71A MCC: Hall C Sunday 0830h

Tools of Seismology: Instruments, Networks, and the Internet Posters *(joint with ED)*

Presiding: **S Malone,** University of Washington**; R J Willemann,** International Seismological Centre

S71A-1048 0830h POSTER

Instrument Testing and First Results From the MOBB Observatory

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The Monterey ocean bottom broadband station (MOBB) was installed on the sea floor in Monterey Bay, 40 km offshore, and at a depth of 1000m from the sea surface, in April 2002. It is a collaborative project between MBARI (Monterey Bay Aquarium Research Institute) and BSL (Berkeley Seismological Laboratory).

The ocean-bottom MOBB station currently comprises a three-component seismometer package, a current-meter, and a recording and battery package. A differential pressure gauge (DPG) with autonomous recording (e.g. Cox et al., 1984) will be deployed in the vicinity of the seismometer package during the next data recovery dive, in September 2002.

The seismic package contains a low-power (2.2W), three-component CMG-1T broadband seismometer system, built by Guralp, Inc., with a three-component 24-bit digitizer, a leveling system, and a precision clock. The seismometer package is mounted on a cylindrical titanium pressure vessel 54cm in height and 41 cm in diameter, custom built by the MBARI team and outfitted for underwater connection.

Because of the extreme sensitivity of the seismometer, air movement within the pressure vessel must be minimized. We describe the extensive testing and insulation procedures performed at BSL. Among others, the top of the pressure vessel was thermally isolated with two inches of insulating foam and reflective Mylar. The sides were then insulated with multiple layers of reflective Mylar space blanket, and the vessel was filled with argon gas.

The installation was completed during 3 dives (9-11 April, 2002), with the help of the MBARI ROV Ventana and ship Point Lobos. The site was revisited on April 22nd, to check the functioning of the system and 3Mb of data were then retrieved. The ship and ROV returned to the site two months later, on June 27th, and the data recording and battery modules were replaced, in the first of a series of such dives planned over the next 3 years.

Many regional and teleseismic earthquakes have been well recorded and the mass position signals indicate that the instruments are progressively settling. Preliminary analysis of data retrieved during the 2002 summer and fall dives will be presented. In particular, we will discuss long period background seismic noise and how it correlates with signals recorded on the current-meter and DPG, leading to possible improvements.

S71A-1049 0830h POSTER

Deployment of a Long-Term Broadband Seafloor Observatory in Monterey Bay

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MOBB (Monterey bay Ocean floor Broad Band project) is a collaborative project between the Monterey Bay Aquarium Research Institute (MBARI) and the Berkeley Seismological Laboratory (BSL). Its goal is to install and operate a permanent seafloor broadband seismic station as a first step towards extending the on-shore broadband seismic network in northern California to the seaside of the North-America/Pacific plate boundary, providing better azimuthal coverage for regional earthquake and structure studies.

The successful MOBB deployment took place 40km off shore at a water depth of 1000m during three dives on April 9-11, 2002. The seismometer was buried in a 60-cm deep caisson, which was later back filled with glass beads to stabilize the instrument. New tools, including a high-pressure water-jet excavator, were developed for the ROV Ventana to accomplish these tasks.

The ocean-bottom MOBB station currently comprises a three-component seismometer package, a current-meter, and a recording and battery package. Data recovery dives, during which the recording and battery package will be exchanged, are planned every three months for the next three years. A differential pressure gauge (DPG) (Cox et al., 1984) will be deployed as part of the recording package during the next data recovery dive in September 2002.

The station is currently recording data autonomously. Eventually, it will be linked to the planned (and recently funded) MARS (Monterey Accelerated Research System;

URL: http://www.mbari.org/mars/

) cable and provide real-time, continuous seismic data to be merged with the rest of the northern California real-time seismic system. The data are archived at the NCEDC for on-line availability, as part of the Berkeley Digital Seismic Network (BDSN).

This project follows the 1997 MOISE experiment, in which a three-component broadband system was deployed for a period of three months, 40km off shore in Monterey Bay. MOISE was a cooperative program sponsored by MBARI, UC Berkeley and the INSU, Paris, France (Stakes et al., 1998; Romanowicz et al., 1998; Stutzmann et al., 2001). During the MOISE experiment, valuable experience was gained on the technological aspects of such deployments, which contributed to the success of the present MOBB installation.

URL: http://www.seismo.berkeley.edu/seismo/monterey/

S71A-1050 0830h POSTER

Source depth dependence of micro-tsunamis recorded with ocean-bottom pressure gauges and its use for earthquake source parameter studies

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The Japan Marine Science and Technology Center (JAMSTEC) installed a deep seafloor observatory with a 240-km-long fiber optic cable south of Hokkaido, Japan in 1999. Two ocean-bottom pressure gauges on the cabled observatory were deployed at depths of 2283 m and 2248 m. The relative resolution of pressure measurements is approximately 3 Pa, which is approximately equivalent to 0.3 mm in sea level change. Micro-tsunami waves with a maximum amplitude of 4 to 6 mm were detected with the ocean-bottom pressure gauges on the cabled observatory following the January 28, 2000 earthquake (Mw 6.8) in the southern Kuril subduction zone. We model the observed micro-tsunami and estimate the focal depth and other source parameters such as fault length and slip amount using a grid searching algorithm with the least squares minimization. From these parameters, we estimate the seismic moment and stress drop. The focal depth and stress drop for the January 28, 2000 earthquake is estimated to be 50 km and 7 MPa, respectively, with possible ranges of 45 - 55 km and 4 -13 MPa. The fault length is estimated to be 15 km, with possible ranges of 10 - 20 km, which is the same as that from the aftershock distribution previously determined. The corresponding estimate for seismic moment is 2.72×10^{19} Nm with possible ranges of 2.25×10^{19} - 3.18×10^{19} Nm. The focal depth and stress drop strongly suggest that the earthquake was an intra-slab event in the subducting Pacific plate. Standard tide gauges along the nearby coast did not record any tsunami signal. The high-precision tsunami measurements with ocean-bottom pressure gauges offshore thus make it possible to determine fault parameters of moderate-sized earthquakes in subduction zones using open-ocean tsunami waveforms.

S71A-1051 0830h POSTER

Detection of Mantle and Core P-Arrivals, and Analysis of T-waves, Recorded on Ocean Sound-Channel Hydrophones Along the Mid-Atlantic Ridge (10°-35°N)

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In February 1999, a consortium of U.S. investigators (NSF and NOAA) began long-term monitoring of Mid-Atlantic Ridge (MAR) seismicity between 15°N and 35°N. The experiment uses six NOAA/PMEL autonomous hydrophones moored within the SOFAR channel on the MAR flanks. The hydrophones record the hydroacoustic tertiary phase or *T*-wave of oceanic earthquakes from throughout the Atlantic basin. The low attenuation properties of the SOFAR channel allow for a reduction in the detection threshold (cutoff Magnitude) of MAR earthquakes from M_C=4.7 of the land-based seismic networks to M_C=3.0 with the hydrophones (Bohnenstiehl et al., 2002). The improved